

UNCLASSIFIED

AD NUMBER	
AD366242	
CLASSIFICATION CHANGES	
TO:	UNCLASSIFIED
FROM:	CONFIDENTIAL
LIMITATION CHANGES	
TO: Approved for public release; distribution is unlimited.	
FROM: Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; MAR 1956. Other requests shall be referred to Armament Research and Development Command, Aberdeen Proving Ground, MD.	
AUTHORITY	
26 Dec 1979 per doc markings; ARRADCOM ltr 26 Dec 1979	

THIS PAGE IS UNCLASSIFIED

UNCLASSIFIED

AD NUMBER

AD366242

CLASSIFICATION CHANGES

TO:

CONFIDENTIAL

FROM:

SECRET

AUTHORITY

31 Mar 1968, DoDD 5200.10

THIS PAGE IS UNCLASSIFIED

UNCLASSIFIED

AD 366242

CLASSIFICATION CHANGED
TO: UNCLASSIFIED
FROM CONFIDENTIAL

AUTHORITY:

ARRADCOM 1+C
26 DEC 79



UNCLASSIFIED

SECURITY

MARKING

The classified or limited status of this report applies to each page, unless otherwise marked.

Separate page printouts MUST be marked accordingly.

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18, U.S.C., SECTIONS 793 AND 794. THE TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.

~~SECRET~~

366242

SECRET



SECRET

Aberdeen Proving Ground

MARYLAND

THE INCENDIARY EFFECTIVENESS OF HEI FILLERS

IN 20MM PROJECTILES (U)

THIS DOCUMENT CONSISTS OF³¹ PAGES

COPY.....¹¹...OF.....⁷...COPIES, SERIES.....

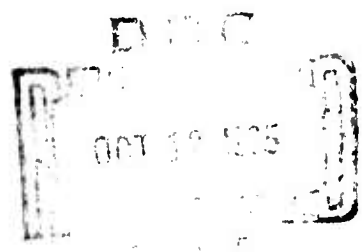
D.A. PROJECT NO. - 503-05-010

DEVELOPMENT AND PROOF SERVICES

SEVENTH Report OCO Project No. TB3-0238A

Regrading data cannot be predetermined ^B ABERDEEN PROVING GROUND, MD-415

copy



SECRET

DDC CONTROL
NO. 54749

DOWNGRADED AT 12 YEAR
INTERVALS: 1990, 2000, 2010

02C-8a

SECRET

ABERDEEN PROVING GROUND

MARYLAND

REFERENCE COPY

APillersdorf/vl

366242

REPRODUCTION OF THIS DOCUMENT IN WHOLE OR IN PART IS PROHIBITED EXCEPT WITH PERMISSION OF THE ISSUING OFFICE. HOWEVER, ASTIA IS AUTHORIZED LIMITED REPRODUCTION AND NUMBERED DISTRIBUTION IN LOCAL SERIES WHEN TOTAL ADDITIONAL DISTRIBUTION LIST IS FURNISHED THE ISSUING OFFICE.

6 THE INCENDIARY EFFECTIVENESS OF HEI FILLERS

IN 20MM PROJECTILES (U)

ORDNANCE CORPS PROJECT NO. TB3-0238A

REPORT NO. 14

DEPARTMENT OF THE ARMY-ORDNANCE NO. 503/05/010, 000 TB3/0238A

10 Arthur Pillersdorf. AUTHORITY

Memorandum from Director, BRL to Director, DAPS, 20 Dec 1954

Teletype from Chief of Ordnance - ORDTS to APG

11 Mar 56,

12 31p.

DATES OF TEST

May 1953 - March 1956

RETAIN OR DESTROY PER AR 380-5 AND AR 365-222 OR COMPARABLE AF OR NAVY REGULATIONS. DO NOT RETURN

DDC CONTROL NO. 54749

THIS DOCUMENT CONSISTS OF 3 PAGES

COPY 1 OF 25 COPIES, SERIES

SECRET

Regrading data cannot be predetermined

encl 1' to ltr to AS-12 dated 2-18-57

This document contains information affecting the National Defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794. Its transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

ordby 5/400.112/77 1957

57AA 15540

SECRET

THE INCENDIARY EFFECTIVENESS OF HEI FILLERS IN 20MM PROJECTILES (U)

ABSTRACT

Objective

To evaluate the incendiary effectiveness of various fillers in 20mm projectiles against aircraft type fuel cells filled with aviation gasoline.

Summary

Critical distances for obtaining fires against each of two different target arrangements were determined for fourteen combinations of shell types and fillers. Standard target set-ups (B-2 In-Line and Miss-Distance) were used for the aviation gasoline fuel cells.

Conclusion

The behavior of the filler combinations was consistent with earlier trends. Projectiles modified to perform better against one type of target set-up (e.g., B-2 mockup) were poorer against the other type of target, i.e., Miss-Distance.

Recommendations

1. Further investigation of a promising design incorporating a follow-through slug be conducted.
2. Investigations be made in larger calibers, in the hope that an optimum combination of performance characteristics may lie in this direction.

SECRET

SECRET

THE INCENDIARY EFFECTIVENESS OF HEI FILLERS IN 20MM PROJECTILES (U)

CONTENTS

	Page No.
INTRODUCTION	1
DESCRIPTION OF MATERIEL	1
DETAILS OF TEST	4
CONCLUSIONS	9
RECOMMENDATIONS	9
REFERENCES	11
DISTRIBUTION	12
APPENDIX A: Correspondence	A-1
APPENDIX B: Round-by-Round Firing Data	B-1

SECRET

I. INTRODUCTION

A. Standard 20mm high explosive incendiary projectiles such as the M97 contain tetryl and an incendiary mixture in fixed proportion. The combination of fillers is used to give fragmentation and non-incendiary effectiveness as well as fuel ignition.

B. The major performance feature of interest in these tests, however, is the ability of the projectile to produce fuel fires in an aircraft under varying conditions of attack. Since impacts can occur on an aircraft at some distance in line with or to the side of a fuel cell proper, the non-direct-hit incendiary effectiveness of this type projectile is a major criterion in projectile performance.

C. An important characteristic of incendiary projectiles, therefore, is the maximum distance from projectile impact to an aircraft fuel cell wall, both laterally and along the projectile trajectory, at which a fuel fire can be obtained.

D. Considerable, but incomplete, data had been obtained prior to the firings described in this report. These earlier firings indicated that, for fuel cell walls perpendicular to the trajectory, the incendiary mix was the predominant damage factor. Conversely, against a fuel cell with the target wall parallel to the trajectory, high explosive filler had the major damage potential, providing the fragmentation necessary to produce fuel leakage.

13

E. The ammunition used in the tests reported herein had not only varying ratios of explosive-incendiary mix, but also various types of incendiary filler. (See descriptions of British BRF round and Denver Incendiary Mix.)

II. DESCRIPTION OF MATERIEL

A. 20mm Mann barrels mounted on Frankford Arsenal rests were used to fire the projectiles tested, at a gun-to-target range of approximately 50 to 100 feet.

B. The target fuel cells were of the self-sealing, B50 type, 90% full of aviation grade gasoline. When the fuel cells were damaged or non-sealing leaks resulted from firing, composite patches of rubber and aluminum plates were applied over the damaged cell openings. This procedure has been routine in tests of the type described. Firings were conducted under a wide range of ambient temperatures, during various seasons of the year.

C. The ammunition types are described in the Table in E, below. Variations in loading were achieved in Development and Proof Services assembly plants. The exceptions to this local loading procedure were the SID round and the British BRF 521 rounds, fired as received from Weapon System Laboratory of the Ballistic Research Laboratories. The fuzes used were of the M505 and T196E4 point-detonating type, except that the British BRF rounds

SECRET

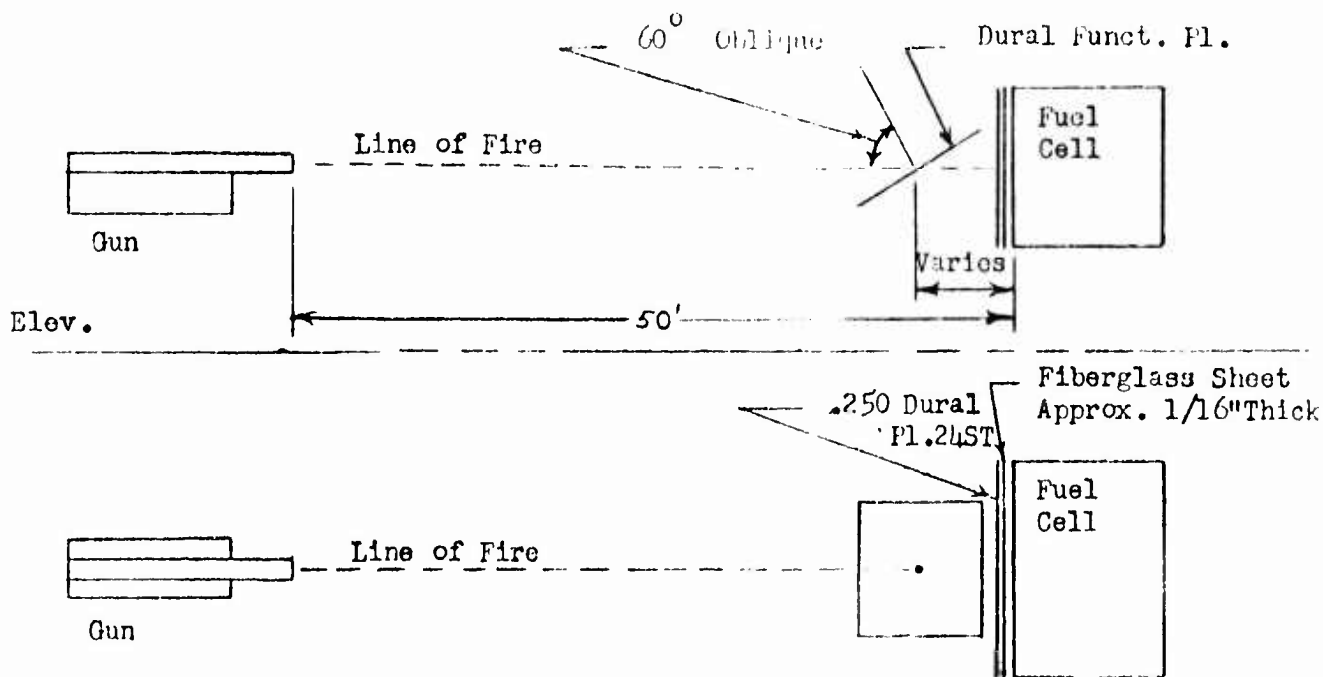
were fused with the MK1 RG-917. Teteryl filler was pressed at 40,000 psi, Incendiary Mix 142 at 20,000 psi or less.

D. The target B50 type fuel cell was mounted on an angle-iron stand which served to support the cell in a relatively unconfined position. The burster plates for the test ammunition were sheets of locally available 24S-T aluminum placed at 60° obliquity. For the B-2 mockup phase, .040" dural was the first plate and .125" or .250" dural was the second plate in the target set-up. For the Miss-Distance firings, .040" or thicker projectile functioning plates were used. Figure 1 on the following page illustrates the two set-ups.

SECRET

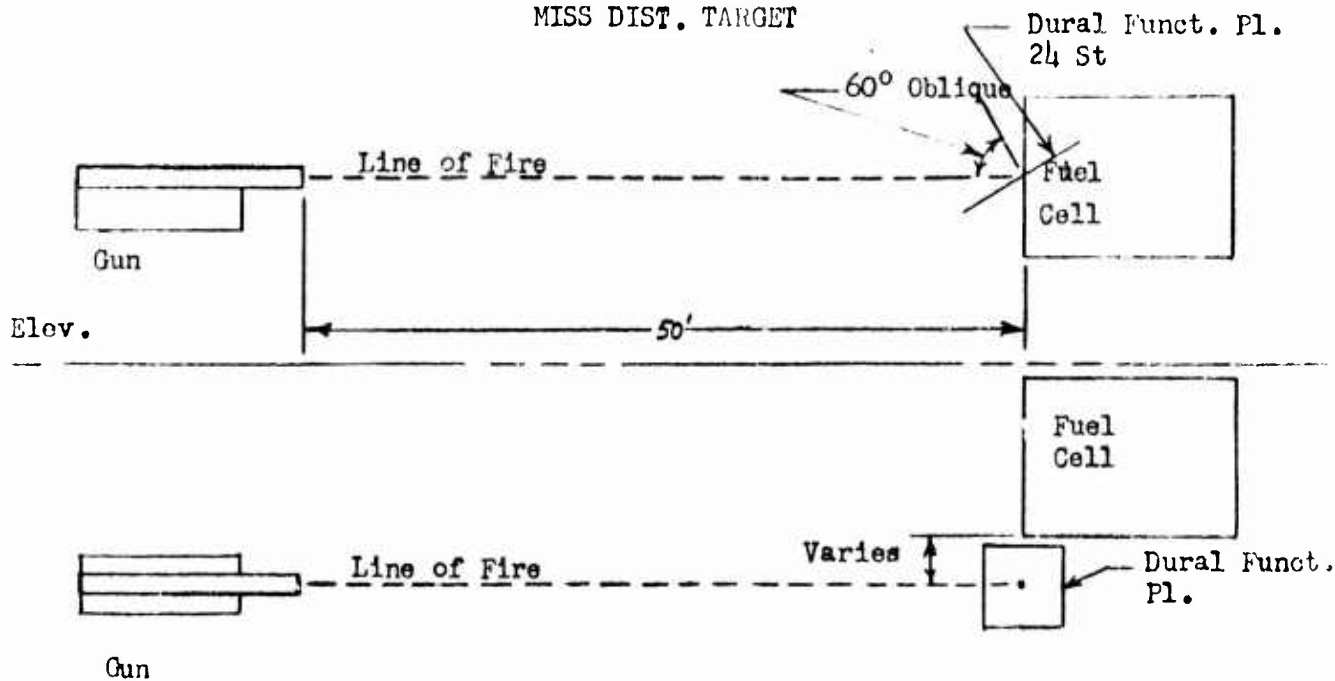
INCIDENTARY EFFECTIVENESS TARGETS

B-2 TARGET



Plan

MISS DIST. TARGET



Plan

SECRET

E. Table of 20mm Ammunition Type-Filler Combinations Fired

<u>TYPES</u>	<u>FILLERS</u>
HEI, M97 and T282E1 (four fillers each)	- 0% Incendiary Mix 142, 100% Tetryl 30% Incendiary Mix 142, 70% Tetryl 70% Incendiary Mix 142, 30% Tetryl 90% Incendiary Mix 142, 10% Tetryl
HEI, T282E1 (Mod.)	- Loaded by Denver Research Institute (two grams of Zirconium, 20-60 mesh, Tyler screen, in base, eleven grams MOX-2B main charge, two grams 97/3 RDX/wax top-off charge)
HEI, T282E1 (Mod.)	- Same as above but without RDX/wax top-off charge
HEI, T282E1	- Standard (MOX-2B)
HEI, T282E1	- SID (Lead Shot and Zirconium Filler)
HEI, T216E1	- Denver Incendiary Mix, as for first T282E1 (Mod.) above
HEI, T216E1 (Mod.)	- Special Slug, 135 grains (.314 inch high by .526 inch diameter) added in base of shell.
BRF - 521	- British bromine pentafluoride main charge with incendiary mix and British fuze

F. Sample Filler Weights of HEI Projectiles:

<u>SHELL</u>	<u>WT. EMPTY</u>	<u>LOADED</u>	<u>WT. 1M 142</u>	<u>WT. TETRYL</u>	<u>RATIO HE/I</u>
M97	100.52 gms	108.93	5.88 gms	2.52 gms	30/70
T216	64.41 gms	80.18	4.77 gms	11.01 gms	70/30

III. DETAILS OF TEST

A. PROCEDURE

1. Firings were conducted at particular distances in the B-2 target phase for which previous data was limited. The functioning plate was usually at 60° obliquity and the distances between functioning plate and target fuel cell were never greater than 96 inches along the trajectory of the projectile. For the Miss-Distance phase, groups of three rounds were fired to determine a lateral distance, between point of impact and side of fuel cell, at which no fires occurred. These distances ranged from 6 to 27 inches. At the conclusion of firing, surplus aviation grade gasoline was drained from the target fuel cell and used to fill the target cells for subsequent firing. Gasoline fires were rapidly extinguished by the use of foam and CO₂ delivered from fire-fighting trucks.

SECRET

B. RESULTS

1. Summaries of firing data are presented in Figures 2 and 3, which follow this section. Round-by-round data for the M97 and T282 standard and modified, T216E1 standard and modified, and the BRF 521 projectiles are presented in Table 3 in Appendix B.

2. The data presented in the aforementioned tables and graphs contains information obtained in previous firings (Ref. APG Firing Records P-55880 and P-55926), as well as data from the subject firings.

3. Against the In-Line, or B-2 target, both the 20mm HEI M97 and T282E1 projectiles, when loaded with 90% of IM 142 and 10% tetryl, yielded fires (1 in 3 for each projectile) at the maximum fuel cell distance tested. This distance (functioning plate to fuel cell masking plate) was 96 inches. Generally, as the percentage of tetryl was increased, the maximum distance at which fires occurred decreased. With a 100% tetryl load, no fires were provided by the T282E1 projectile in three trials when the plate to target distance was 18 inches.

4. Against the lateral or Miss-Distance target, the T282E1 type projectile loaded with 100% tetryl yielded a fire (1 out of 3 trials) at a maximum distance between impact point and fuel cell wall of 18 inches. As the percentage of incendiary mix was increased, and that of high explosive decreased correspondingly, the incendiary effectiveness of T282E1 and M97 types against this target decreased.

5. The SID (Modified T282E1) round was effective in starting fires against the B-2 or In-Line target mockup at all distances including the maximum tested (96 inches), where it produced 3 fires in 3 trials. The same round was relatively ineffective against the Miss-Distance target mockup (no fires in 3 trials at nine inches).

6. The special modification of the T216E1 involving the addition of a steel slug to the bottom of the shell cavity appeared to improve the performance of the round slightly. This modified round yielded 1 fire in 3 trials at B-2 target distance of both 45 inches and 63 inches and caused large single leaks in the cells even when no fires resulted. The standard T282E1 projectile yielded a fire (1 in 7 trials) at a maximum distance of only 36 inches against the same target set-up. It appeared also that only small leaks in the target cell wall resulted at 36 inches or greater distances when the unmodified T282E1 was fired.

7. The British BRF 521 round yielded at least 1 fire at all B-2 target distances tested, up to the maximum of 96 inches. Against the Miss Distance target, this round failed to show effective performance.

FIGURE 2

(No. Fires/No. Trials)

FIRE FREQUENCY VS PROJECTILE IMPACT DISTANCE

20MM HEI PROJECTILE VS B-2 (IN-LINE) TARGET .040 in. Dural 1st Plate
.125 in. Dural 2nd Plate

PROJECTILE AND FILLER	DISTANCE BETWEEN PLATES 1 & 2 (inches)										TYPE OF GASOLINE LEAKAGE
	18	27	36	45	54	63	72	96			
M97 with 0% IM 142/ 100% Teteryl	0/1*	-	2/3, 0/2*	1/3	1/2, 0/3*	2/2	0/3*	-	Small		
M97 (Std) with 30/70	7/7	5/8	2/4	0/3	0/3	-	-	-	Small		
M97 with 70/30	3/3	-	3/3	2/3	1/1	1/1	1/3	0/3*	Medium		
M97 with 90/10	3/3	-	3/3	4/4	1/1	1/3	0/1, 1/2*	1/3*	Large		
BWP-521	-	-	-	-	2/3*	1/3*	2/3*	1/3*	Large		
High Capacity T282E1 with 0% IM 142/100% Teteryl	0/3	-	-	0/1	-	-	-	-	Small		
T282E1 with 30/70	1/3	1/3	0/3*	-	-	-	-	-	Medium to Large		
T282E1 with 70/30	3/3	-	3/3	3/3	2/3*	0/3*	-	-	Medium to Large		
T282E1 with 90/10	3/3	-	3/3	3/3	-	-	3/3*	1/3*	Large		

SECRET

FIGURE 2 (Contd)

PROJECTILE AND FILLER	DISTANCE BETWEEN PLATES 1 & 2 (inches)						TYPE OF GASOLINE LEAKAGE
	18	27	36	45	54	63	
T216E1 (MOX2B/Zr)**	3/3(12"), 2/3*	3/4*	1/7*	0/3*	-	-	Small
T216E1 (BRL MOD.) MOX2B plus 135 gr. .526 in. dia. base plug	-	-	-	1/3*	0/3*	1/3* 0/5*	Large
T282 (Std) MOX2B	5/5	7/10	3/9, 0/1*	0/2, 0/1*	-	-	Small
T282 (MOX2B/2 grains Zr)**	4/4*	2/5*	2/6*	-	-	-	Small
T282 (MOX2B, Zr, w/o topoff)**	-	-	2/2*	-	-	3/3*	Large
T282-S.I.D. (Lead Shot plus Zr)**	-	-	-	-	1/1*	1/1*	Large

* = Most Recent Firings

** = "Denver Incendiary Mix."

SECRET

FIGURE 3

FIRE FREQUENCY: 20MM HEI PROJECTILE VS MISS-DISTANCE TARGET

PROJ. TYPE & FILLER	LATERAL DISTANCE FROM CELL (INCHES)						LEAKAGE ***
	<u>6</u>	<u>9</u>	<u>12</u>	<u>15</u>	<u>18</u>	<u>27</u>	
M97 0% IM 142/ 100% Tetryl	-	-	2/3*	-	0/5*	-	M to L at 12" Small at 18"
M97 (Std) 30/70	2/2	2/5	2/3	2/3	0/3	-	- -
M97 70/30	1/1	0/1,2/3*		0/3*	0/2*	-	Large at 9" Small at 18"
M97 90/10	0/3	-	-	-	-	-	- -
T282E1 (High Cap.) 0% IM/100% Tetryl	-	1/3*	-	-	1/3*	-	Med. at 9" Sm. at 18"
T282E1 30% IM/70% Tet.	-	0/3*	1/3*	-	0/3*	-	M & S at 9" S at 18"
T282E1 70% IM/30% Tet.	-	1/3*	-	0/3*	-	-	S at 15"
T282E1 90% IM/10% Tet.	-	-	-	-	-	-	-
BRF 521	1/1*	0/3*	-	-	-	-	S at 9" L at 6"
T216E1 (MOX / Zr.**)	-	3/3	-	-	0/3	0/3	-
T216E1 w/Heavy Base and MOX2B	-	-	-	-	1/3*	0/3*	Small
T282 (Std) MOX	-	3/3	-	-	1/3	0/3	-
T282 (MOX / Zr.**)	-	3/3	-	-	0/3	0/3	-
T282 (MOX / Zr.) w/o Topoff	-	0/2*	-	-	-	-	None
T282E1 (S.I.D.) (Lead Shot / Zr.)	-	0/3*	-	-	-	-	None

* - More recent firings ('55 - '56)

** - "Denver Incendiary Mix".

*** - S - small, M - medium, L - large

SECRET

C. OBSERVATIONS

1. An explosive type reaction accompanied the functioning of the BRF round. This reaction is attributed to the violent combination of the bromine pentafluoride filler with the hydrocarbon fuel. Target fuel cells were lifted and ruptured more violently by this than by the other rounds fired under the same test conditions. Consistent fires were not produced by this round, although those produced were characteristically violent.

2. The increased leakage and apparent damage potential of the T216E1, modified at this station by inserting a 135-grain, .526-inch diameter steel slug in the bottom of the shell cavity, is worthy of further investigation.

IV. CONCLUSIONS

A. The general expectations for the two types of targets used are substantiated in that:

(1. When the trajectory of the projectile is perpendicular to the fuel cell wall (B-2 mockup target), higher percentages of incendiary mix generally increase the incendiary effectiveness of 20mm rounds.

(2. When the trajectory is parallel to the fuel cell wall (Miss-Distance target), higher percentages of incendiary mix decrease the maximum distance at which fuel fires can be caused.

B. The addition of two grams of ~~zirconium~~^{zirconium} of 20 - 60 mesh, Tyler screen, in the base of the T282E1 projectile did not enhance the incendiary performance of this round.

C. The modification of the T216E1 utilizing a steel slug in the shell cavity has promise for increased ammunition effectiveness.

V. RECOMMENDATIONS

A. Consideration should be given to varying the weight and granulation of the zirconium mix in order to improve its incendiary effectiveness.

B. The use of an inner projectile slug, and of a slug integral with the shell base, for follow-through incendiary effectiveness should be further investigated.

C. The same kinds of tests should be conducted for projectiles of 30mm and larger caliber to determine the optimum compromise for incendiary and structural damage.


SECRET

D. Consideration should be given to development of a single, versatile target configuration for incendiary effectiveness evaluation.

SUBMITTED:


ARTHUR PILLERSDORF
Project Engineer

REVIEWED:


HERBERT L. ROSENBERG
Chief, Armor and Ammunition
Effectiveness Division

APPROVED:


BENJAMIN S. GOODWIN
Assistant Director for Engineering Testing
Development and Proof Services

SECRET

REFERENCES

1. Memorandum from Director, BRL to Director, D&PS, 20 December 1954.
2. Teletype 31707 from Office, Chief of Ordnance - ORDTB to Aberdeen Proving Ground, November 1954.
3. APG Firing Records Nos. P55880 and P55926.

SECRET

DISTRIBUTION

<u>COPY NO.</u>	<u>NAME AND ADDRESS</u>	<u>NO. COPIES</u>
	Chief of Ordnance Department of the Army Washington 25, D. C.	
3	ATTN: ORDTS	1
4	ORDTX-AR	1
5	ORDTA	1
6	ORDTB	1
	Bureau of Ordnance Department of the Navy Washington 25, D. C.	
7	ATTN: ReS2	1
8	Re06	1
9	Re05	1
10	ReS1	1
	Armed Services Technical Information Center Document Service Center Knott Building Dayton, Ohio	
11		1 vellum
	Commander Wright Air Development Center Wright-Patterson Air Force Base, Ohio	
12	ATTN: WCLPR	1
13	WCLSS	1
14	WCRTI-4	1
	Naval Air Development Center Johnsville, Pennsylvania	
15		1
	Commander Air Force Armament Center Eglin Air Force Base, Florida	
16	ATTN: ACWM	1
17	ACOTT	1
18	ACZ	1
19	ACRG	1
	Commander Air Research & Development Command ATTN: RDTDAG Box 1395 Baltimore 3, Maryland	
20		1
	Commanding General Frankford Arsenal Philadelphia 37, Pa.	
21	ATTN: ORDBR-MSD	1

SECRET

DISTRIBUTION

<u>COPY NO.</u>	<u>NAME AND ADDRESS</u>	<u>NO. COPIES</u>
22	Commanding Officer Lake City Arsenal Independence, Missouri ATTN: Industrial Engineering Division	1
23	Navy Liaison Officer Aberdeen Proving Ground, Maryland ATTN: Lt. Comdr Ray Scholl	1
24	AMC Liaison Officer Aberdeen Proving Ground, Maryland ATTN: Major John Adams	1
25	Weapons Systems Laboratory Ballistic Research Laboratory Aberdeen Proving Ground, Maryland	1
0	Technical Library Branch Aberdeen Proving Ground, Maryland	Original
1		1 copy - Reference
2		1 copy - Record

SECRET

APPENDICES

A, CORRESPONDENCE	A-1
B, ROUND-BY-ROUND DATA	B-1

SECRET

SECRET

COPY/v1

APPENDIX A

Director, Development & Proof Services
Attn: Mr. H. L. Rosenberg

Mr. RGBernier/amp/27215
20 December 1954

Director, Ballistic Research Laboratories

Firings to Investigate the Effect of HEI Fillers

1. General. It is desired to obtain more data on the effect of HEI filler on the maximum distance from a fuel cell wall at which ignition can be obtained. Against tank walls perpendicular to the trajectory (B(2) mock-up) the incendiary mix seems to have the most value but against tank walls parallel to the trajectory (miss distance mock-up) the HE seems to have the most value. A considerable amount of data already has been collected on this subject (APG Firing Records P-55880 and P-55926 and others), but more is needed to complete the evaluation.

2. Firings. The following specially filled 20mm shell will be needed, and it is believed that the filling can be accomplished at the APG HE plant. All the projectiles should be assembled with M505 sensitive fuzes and cases convenient for firing at approximately 2900 fps. The suggested firing conditions are also listed.

Min* Quantity Needed	Shell Body (20mm)	% Incendiary (IM 142 or IM 11)	% HE Tetryl	Firings Needed	
				B(2) M.U. Distance (in.)	Miss Dist M. U.
6	M97	0	100	36	12
3	"	Standard	Standard	45	None
6	"	70	30	45	9
3	"	90	10	45	None
6	T216 or T282	0	100	18	18
6	"	30	70	27	12
6	"	70	30	45	9
3	"	90	10	45	None

*Additional samples of three rounds should be fired at a slightly greater distance if fires occur.

Firings should be conducted against B-50 tanks filled with aviation gasoline. Dural approx. .051" thick may be used for function plate on miss distance firings. For the B(2) mock-up firings approx. .040" is adequate for the function plate and .125" for the second plate, but the backing board and second plate should cover the entire impact face of the tank. Shell filler weights should be recorded. For the previous firings the IM 142 was pressed at 40,000 psi and the tetryl topping off at 20,000 psi. The fuze cavity was drilled .385" / .010".

SECRET

3. Firings are chargeable to Project TB3-0238A. Results should be classified "Confidential". Work order 962-010-01.

G. E. PARSONS, Jr.
Lt Colonel, Ord. Corps
Assistant to Director
Ballistic Research Laboratories

SECRET

COPY/v1

EUB030

FR UETGH

DE UEPDA 07J

R 151430Z

FM COFORD WASHDC

TO CG ABERDEEN PG MD

DA GRNC

FOR TERMINAL BALLISTICS OF A/C AMM BR CMM D AND PS FROM ORDT'S
KLINE TT ORD 31707 RE FONECON KLINE-ROSENBERG 10 NOV 54 CMM
APPROXIMATELY 250 EACH T282E1 AND T216E1 20MM HVI PROJECTILES HAVE
BEEN FORWARDED YOUR STATION FROM DENVER RESEARCH INSTITUTE PD THESE
PROJECTILES CONTAIN 2 GRAINS DENVER INCENDIARY MIX AS BASE CHARGE
WITH BALANCE CONVENTIONAL MOX CAPPING PD REQUEST YOUR STATION CONDUCT
SUCH TESTS AS NECESSARY TO DETERMINE COMPARATIVE BLAST AND INCENDIARY
PERFORMANCE OF THESE PROJECTILES AND CONVENTIONAL LOADED ONES UNDER
SEA LEVEL AND ATMOSPHERIC CONDITIONS PD CHARGE COSTS TO PROJECT
TS1-47

CFN 31707 10 54 250 T282E1 T216E1 20MM 2 TS1-47

15/1539Z

SECRET

APPENDIX B

TABLE 3 - ROUND-BY-ROUND DATA

Projectile: M-97 0% IM 100% Tetryl

TEST ROUND NO.	TARGET	DISTANCE	FIRE		LEAK IN CELL
			YES	NO	
158	B-2	36		X	
159	B-2	36	X		
160	B-2	36	X		
161	B-2	45		X	
162	B-2	45	X		
163	B-2	45		X	
169	B-2	54		X	
170	B-2	54	X		
171	B-2	63	Disregard		
172	B-2	63	X		
179	MD	12	Disregard		
180	MD	12	Disregard		
181	MD	12		X	Large
182	MD	12	X		Medium
183	MD	12	X		Large
191	MD	18		X	Small
192	MD	18		X	Small
193	MD	18	Disregard		
194	MD	18	Disregard		
195	MD	18		X	Medium
286	MD	18		X	Small
287	B-2	72		X	Small
288	B-2	72	Disregard		
289	B-2	72		X	Small
290	B-2	72		X	Small
293	MD	18		X	Small
298	B-2	54		X	Small
299	B-2	54		X	Small
300	B-2	54		X	Small
301	B-2	36		X	Small
302	B-2	36		X	Small
303	B-2	18		X	Small

B-1

SECRET

SECRET

Projectile: M-97 (Std) 30% IM 70% Tetryl

<u>TEST</u> <u>ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK</u> <u>IN CELL</u>
			<u>YES</u>	<u>NO</u>	
1	B-2	45		X	
2	B-2	22		X	
3	B-2	12	Disregard		
4	B-2	18	X		
5	B-2	45		X	
6	B-2	45		X	
7	B-2	27	X		
8	B-2	27		X	
295	B-2	54		X	Small
296	B-2	54		X	Small
297	B-2	54		X	Small
304	B-2	27	X		Medium

Projectile: M-97 70% IM 30% Tetryl

<u>TEST</u> <u>ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK</u> <u>IN CELL</u>
			<u>YES</u>	<u>NO</u>	
152	B-2	45	X		
153	B-2	45		X	
154	B-2	45	X		
173	B-2	54	X		
174	B-2	63	X		
175	B-2	72		X	
176	B-2	72		X	
177	B-2	72	X		
184	MD	9	X		Large
185	MD	9		X	Small
186	MD	9	X		Large
187	MD	18	Disregard		
188	MD	18		X	Small
189	MD	18	Disregard		
190	MD	18		X	Small
210	B-2	96		X	Medium
211	B-2	96		X	Medium
283	MD	15		X	Medium
284	MD	15		X	Small
285	MD	15		X	Small
294	B-2	96		X	Medium

B-2
SECRET

SECRET

Projectile: M-97 90% IM 10% Tetryl

<u>TEST</u> <u>ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK</u> <u>IN CELL</u>
			<u>YES</u>	<u>NO</u>	
155	B-2	45	X		
156	B-2	45	X		
157	B-2	45	X		
164	B-2	45	X		
165	B-2	54	X		
166	B-2	63		X	
167	B-2	63		X	
168	B-2	63	X		
178	B-2	72		X	
196	MD	9	Disregard		
197	MD	9	Disregard		
198	MD	9	Disregard		
199	MD	9	Disregard		
203	B-2	72	X		Large
204	B-2	72	Disregard		
205	B-2	96	Disregard		
206	B-2	72	Disregard		
207	B-2	96		X	Large
208	B-2	96	Disregard		
209	B-2	96		X	Large
291	B-2	72		X	Large
292	B-2	96	X		Large

B-3

SECRET

SECRET

Projectile: T282 0% IM 100% Tetryl

<u>TEST</u> <u>ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK</u> <u>IN CELL</u>
			<u>YES</u>	<u>NO</u>	
95	B-2	18	Disregard		
96	B-2	18		X	
97	B-2	18		X	
98	B-2	18		X	
110	B-2	45		X	
116	MD	18		X	
117	MD	18		X	
118	MD	18	Disregard		
119	MD	18	X		
202	MD	9		X	Medium
328	MD	9		X	Medium
331	MD	9	X		Medium

Projectile: T282 30% IM 70% Tetryl

<u>TEST</u> <u>ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK</u> <u>IN CELL</u>
			<u>YES</u>	<u>NO</u>	
99	B-2	27		X	
100	B-2	27	Disregard		
101	B-2	27	Disregard		
102	B-2	27		X	
103	B-2	27	X		
120	MD	12		X	
121	MD	12	X		
122	MD	12		X	
200	MD	18		X	Small
201	MD	18		X	Small
311	B-2	36	Disregard		
312	B-2	36		X	Small
313	B-2	36		X	Small
314	B-2	36		X	Small
323	MD	18		X	Small
324	MD	9		X	Medium
329	MD	9		X	Small
330	MD	9		X	Small

B-4

SECRET

SECRET

Projectile: T282 70% IM 30% Tetryl

<u>TEST ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK IN CELL</u>
			<u>YES</u>	<u>NO</u>	
104	B-2	45	X		
105	B-2	45	X		
106	B-2	45	X		
111	MD	9		X	
112	MD	9	Disregard		
113	MD	9	Disregard		
114	MD	9		X	
115	MD	9	X		
315	B-2	54	X		Large
316	B-2	63		X	Medium
317	B-2	54		X	Medium
318	B-2	54	X		Large
319	B-2	63		X	Medium
320	B-2	63		X	Medium
325	MD	15		X	Small
326	MD	15		X	Small
327	MD	15		X	Small

Projectile: T282 90% IM 10% Tetryl

<u>TEST ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK IN CELL</u>
			<u>YES</u>	<u>NO</u>	
107	B-2	45	X		
108	B-2	45	X		
109	B-2	45	X		
212	B-2	72	X		Large
213	B-2	96		X	Large
214	B-2	96	X		Large
215	B-2	96		X	Large
321	B-2	72	X		Large
322	B-2	72	X		Large

B-5

SECRET

SECRET

Projectile: T282 Standard

<u>TEST</u> <u>ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK</u> <u>IN CELL</u>
			<u>YES</u>	<u>NO</u>	
9	B-2	10	X		
10	B-2	18	X		
11	B-2	27	X		
12	B-2	18	X		
13	B-2	18	X		
14	B-2	27		X	
15	B-2	27		X	
16	B-2	36	X		
17	B-2	36	Disregard		
18	B-2	36	Disregard		
19	B-2	45		X	
20	B-2	18	X		
21	MD	9	Disregard		
22	MD	9	X		
23	B-2	45		X	
24	MD	9	X		
73	MD	9	X		
74	MD	18		X	
75	MD	18		X	
76	MD	18	X		
84	MD	27		X	
85	MD	27		X	
86	MD	27		X	
92	B-2	36		X	
93	B-2	36		X	
94	B-2	36		X	
222	B-2	45		X	Small
223	B-2	36		X	Small

SECRET

Projectile: T282 MOX2B / Zr

<u>TEST ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK IN CELL</u>
			<u>YES</u>	<u>NO</u>	
40	B-2	18	X		
41	B-2	18	X		
42	B-2	18	X		
43	B-2	27		X	
44	B-2	27		X	
45	B-2	27	X		
46	B-2	12	Disregard		
47	B-2	36		X	
48	B-2	36		X	
49	B-2	36		X	
50	B-2	18	X		
56	MD	9	X		
57	MD	9	X		
58	MD	9	Disregard		
59	MD	9	X		
60	MD	18		X	
61	MD	18		X	
62	MD	18	Disregard		
63	MD	18	Disregard		
64	MD	18		X	
65	MD	27		X	
66	MD	27		X	
67	MD	27		X	
230	B-2	36		X	Small
231	B-2	27	X		Small
232	B-2	27		X	Small
233	B-2	36	X		Small
234	B-2	36	X		Small

B-7

SECRET

SECRET

Projectile: T216E1 MOX / Zr

<u>TEST</u> <u>ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK</u> <u>IN CELL</u>
			<u>YES</u>	<u>NO</u>	
25	B-2	36	Disregard		
26	B-2	45		X	
27	B-2	45		X	
28	B-2	45		X	
29	B-2	18	X		
30	B-2	18	Disregard		
31	B-2	18		X	
32	B-2	18	Disregard		
33	B-2	18	X		
34	B-2	27	X		
35	B-2	27	X		
36	B-2	27	Disregard		
37	B-2	27	X		
38	B-2	36		X	
39	B-2	36		X	
51	MD	9	Disregard		
52	MD	9	Disregard		
53	MD	9	Disregard		
54	MD	9	Disregard		
55	MD	9	Disregard		
68	MD	9	X		
69	MD	9	Disregard		
70	MD	9	Disregard		
71	MD	9	X		
72	MD	9	X		
77	MD	18		X	
78	MD	18	Disregard		
79	MD	18		X	
80	MD	18		X	
81	MD	27		X	
82	MD	27		X	
83	MD	27		X	
87	B-2	36	Disregard		
88	B-2	36		X	
89	B-2	9	X		
90	B-2	9	X		
91	B-2	9	X		
229	B-2	36		X	Small
225	B-2	36	X		Small
226	B-2	36		X	Small
227	B-2	27		X	Small
229	B-2	36		X	Small

SECRET

Projectile: T282 MOX2B / Zr (Without Topoff)

<u>TEST ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK IN CELL</u>
			<u>YES</u>	<u>NO</u>	
235	B-2	36	X		Large
236	B-2	36	X		Large
237	B-2	72	X		Large
238	B-2	72	X		Large
253	B-2	96		X	Large
254	B-2	96		X	Large
255	B-2	96	X		Large
256	B-2	72	X		Large
267	MD	9		X	None
268	MD	9		X	None

Projectile: T282 SID (Lead Shot / Zr)

<u>TEST ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK IN CELL</u>
			<u>YES</u>	<u>NO</u>	
274	B-2	54"	X		Large
275	B-2	72"	X		Large
276	B-2	96"	Disregard		
277	B-2	96"	X		Large
278	B-2	96"	X		Large
279	B-2	96"	X		Large
280	MD	9		X	None
281	MD	9		X	None
282	MD	9		X	None

SECRET

Projectile: T216E1 (MOX2B) (Heavy Base - Slug added in the bottom of the projectile - Slug Dimensions - Height .314, Diameter .526, Weight 135 grain)

<u>TEST</u> <u>ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK</u> <u>IN CELL</u>
			<u>YES</u>	<u>NO</u>	
216	B-2	72		X	Medium
217	B-2	63	X		Medium
218	B-2	72		X	Medium
219	B-2	72	Disregard		
220	B-2	72		X	Medium
221	B-2	63	Disregard		
228	B-2	63		X	Medium
257	B-2	72		X	Medium
258	B-2	72		X	Medium
259	B-2	63		X	Medium
261	MD	18		X	Small
262	MD	18		X	Small
263	MD	18	X		Small
264	MD	27		X	Small
265	MD	27		X	Small
266	MD	27		X	Small
269	MD	9	Disregard		
305	B-2	54		X	Large
306	B-2	45		X	Large
307	B-2	45		X	Large
308	B-2	45	X		Large
309	B-2	54		X	Large
310	B-2	54		X	Large

SECRET

Projectile: BRF-521

<u>TEST ROUND NO.</u>	<u>TARGET</u>	<u>DISTANCE</u>	<u>FIRE</u>		<u>LEAK IN CELL</u>
			<u>YES</u>	<u>NO</u>	
239	B-2	54		X	Large
240	B-2	54	X		Large
241	B-2	96	Disregard		
242	B-2	96		X	Large
243	B-2	63		X	Large
244	B-2	63	X		Large
245	B-2	63		X	Large
246	B-2	54	X		Large
247	B-2	72		X	Large
248	B-2	72	X		Large
249	B-2	72	Disregard		
250	B-2	72	X		Large
251	B-2	96		X	Large
252	B-2	96	Disregard		
260	B-2	96	X		Large
270	MD	9		X	Small
271	MD	6	X		Large
272	MD	9		X	Small
273	MD	9		X	Small